Comparative Hydration Quantification by ChemCam LIBS Emission Spectra

Sourabh Shubham[1*], Priyabrata Das[2], Amit Basu Sarbadhikari[2]

[1]Indian Institute of Technology, Kharagpur-721302

[2]Physical Research Laboratory, Ahmedabad-380058

*Email: sourabhshubham611@gmail.com

Laser-Induced Breakdown Spectrometer (LIBS) is an instrument that generates plasma by laser vaporization of a sample and records the emission spectra. The emitted spectrum from such targets provides information about the elemental composition. It works on the principle that the excited atoms, ions and simple molecules in the plasma are recorded in the spectrum emitted from the laser-induced target, which eventually gives information regarding the presence/absence and the quantity of the concerned element. Mars Science Laboratory rover (Curiosity) has a ChemCam instrument, which is equipped with LIBS, first time on Mars. One of the main advantages of ChemCam's LIBS instrument is its potential to detect light elements such as hydrogen at fine scales.

In LIBS emission spectra, each element has a characteristic wavelength of emission. At 656.6 nm, the hydrogen (Balmer alpha) emission peak is used for the quantification of hydrogen [1]. However, due to effects such as stark broadening and interference by neighboring emission peaks, H peak height cannot give an accurate measure of hydration. So, for quantification purposes, the hydrogen peak curve is separated from the neighboring emission spectra such as Carbon doublet (C II at 658.0 nm and C II at 658.5 nm), and iron peaks (Fe I at 654.8 nm and Fe I at 659.4 nm). The area under the isolated H peak curve is then normalized by taking a ratio with the area under oxygen emission spectra (triplet at 776 nm), or carbon emission spectra (at 248 nm). The water quantity is best measured from the H peak when the values are normalized w.r.t. oxygen triplet [2]. To isolate and measure the H peak emission area, we have used a Levenberg-Marquardt least-squares minimization algorithm for fitting Lorentz peaks and a linear continuum. Using the normalized area as a proxy for comparison, the hydration content at different point-targets (of similar roughness) is compared.

Upon analyzing the LIBS spectra acquired on certain targets, the hydration proxy suggests a possibly higher hydration content at some targets, which have a visibly indurated surface. Several such targets are analyzed to understand the active surface processes responsible for the creation of these visible surface features.

References: [1] Schröder S. et al. (2015) *Icarus, 249, 43-61.* [2] Rapin W. et al. (2017) *Spectro. Acta Part B 130, 82–100.*